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November 30, 2005

Mr. Ron Bostic
Rocky Flats Project Office
U.S. Department of Energy
10808 Hwy 93, Unit A
Golden, CO 80403

SUBJECT: CONTRACT NO. DE-AC05-00OR22750
FINAL REPORT—VERIFICATION SURVEY OF THE FORMER BUILDING 371 CLOSURE PROJECT, ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE, GOLDEN, COLORADO

Dear Mr. Bostic:

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) has prepared the final report for the former Building 371 Closure Project, Rocky Flats Environmental Technology Site in Golden, Colorado. Comments provided on the draft report have been incorporated into the final report.

Please contact me at (865) 576-5321 or Scott Kirk at (865) 574-0685 should you need additional information.

Sincerely,

Phyllis C. Weaver
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NOTICES

VERIFICATION SURVEY
OF THE
FORMER BUILDING 371 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Prepared by

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Prepared for the
Department of Energy

FINAL REPORT

NOVEMBER 2005

This report is based on work performed under contract number DE-AC05-00OR22750 with the U.S. Department of Energy.

VERIFICATION SURVEY
OF THE
FORMER BUILDING 371 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

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ABBREVIATIONS AND ACRONYMS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
CSV	central storage vault
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DOP	Decommissioning Operations Plan
DQO	data quality objectives
ε_{Total}	Total Efficiency
ESSAP	Environmental Survey and Site Assessment Program
ft^2	square feet
FIDLER	Field Instrument for the Detection of Low-Energy Radiation
HVAC	heating, ventilation, and air conditioning
ITP	Intercomparison Testing Program
IV	independent verification
IVPP	Independent Verification Program Plan
IVT	independent verification team
JHA	job hazard analysis
K-H	Kaiser-Hill Company
KeV	kilo electron volts
m	meter
m^2	square meter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
nCi/g	nanocuries per gram
NIST	National Institute of Science and Technology
NRIP	NIST Radiochemistry Intercomparison Program
ORAU	Oak Ridge Associated Universities
ORISE	Oak Ridge Institute for Science and Education
PDS	pre-demolition survey
PDSR	pre-demolition survey report
RFPO	Rocky Flats Project Office
RFCP	Rocky Flats Closure Project
RFETS	Rocky Flats Environmental Technology Site
SU	survey units
WGP	weapons grade plutonium

VERIFICATION SURVEY
OF THE
FORMER BUILDING 371 CLOSURE PROJECT
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

INTRODUCTION AND SITE HISTORY

The Atomic Energy Commission, predecessor agency to the U.S. Department of Energy (DOE), selected the Rocky Flats site in 1951 to serve as a nuclear weapons component production facility. Production began in 1952 on both nuclear and non-nuclear components with the plutonium pits being the key component. Uranium and beryllium were also utilized in the production of various components and processes. Operations continued until 1989 when environmental and safety concerns temporarily halted operations. There were over 700 structures, such as process and support buildings, that were involved in the site's mission. In 1993, the production mission was permanently ended and a new mission to clean up the site by 2006 was initiated. The site has since been renamed as the Rocky Flats Environmental Technology Site (RFETS).

Kaiser-Hill Company, L.L.C. (K-H), is the DOE contractor responsible for closure of the RFETS by the year 2006. To meet the closure goal, K-H plans to characterize, remediate, perform pre-demolition surveys (PDS) and then demolish each building at the site. This process has been completed for Building 371 and associated support facilities and systems.

The DOE's Rocky Flats Project Office (RFPO) has the responsibility for oversight of closure at RFETS. The RFPO requested the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) to evaluate the basement and sub-basement slabs that will remain six feet below the final finish grade after building demolition.

SITE DESCRIPTION

The RFETS is located approximately 16 miles northwest of Denver, Colorado on State Highway 93 and Cactus Road. RFETS occupies approximately 385 acres within the 6,000-acre DOE

reservation site (Figure 1). The site has been divided into two major operable units, the Industrial Area and the Buffer Zone. Building 371 was located in the northwestern quadrant of the Industrial area (Figure 2).

Building 371 was a four-level reinforced concrete structure containing approximately 315,000 ft^2 of floor space. Building 371 was used primarily for storage, stabilization, and packaging of plutonium, residues, and transuranic wastes. Level 1 was the sub-basement (Survey Areas C and D) which housed the lower part of the central storage vaults (CSV) and stacker retriever maintenance bay. Level 2 was the main basement area (Survey Areas E, F, and G). The basement housed the heating, ventilation, and air conditioning (HVAC) equipment and mechanical utilities. The basement also housed the upper portion of the CSV, maintenance bay, and a small plutonium processing area. Level 3 was the ground floor level and contained the vast majority of the plutonium recovery processing equipment. The Level 4 attic housed much of the building's systems (K-H 2003). Building 371 was designated as a Type 3 facility.

INDEPENDENT VERIFICATION OBJECTIVES

The primary objective of the independent verification (IV) survey was to implement the data quality objectives (DQO) as defined in the Independent Verification Program Plan (IVPP) (ORISE 2004a). The DQOs were designed to evaluate the PDS efforts in Building 371 against the applicable guideline criteria. Specifically, the Independent Verification Team (IVT) verified through the collection of direct gamma activity measurements that the Decontamination and Decommissioning (D&D) contractor complied with the objectives stated in the approved project-specific characterization plan and limits specified in the Building 371 Decommissioning Operations Plan (DOP) (K-H 2003).

IN-PROCESS INSPECTION

To expedite the D&D process, the IVT conducted Type A verification activities, the simpler type of verification consisting of document review, data validation, with potential confirmatory sample analyses. In addition, in-process and final status surveys for Type B verification, independent field measurements and sampling were also performed as needed. The in-process

inspections followed the applicable lines of inquiry as outlined in Appendix A of the IVPP, as appropriate.

Type A verifications were implemented for areas in Building 371 with a low potential for radiological contamination (Phases II and III). Type B verifications were performed primarily in the Phase IV and V areas of Building 371 located six feet below final grade, including the sub-basement and central storage vault, and basement. Historical information and available radiological data were reviewed to ensure that the appropriate actions towards completion of pre-demolition activities had been performed.

DOCUMENT REVIEW

Document reviews of the contractor's PDS plans, sampling plans, and supporting data and documentation were performed. Type A reviews of the Pre-Demolition Survey Reports (PDSR) were performed for the Phase II areas of Building 371 which included area AP/AF; the Building 371 exterior; T376A; T371H, I, J, and K; and Building 376. A Type A verification was completed for Phase III of Building 371. Phase III included Area AP between Column Lines 1-12 and Column Lines T-Y, Building 373, and Cooling Tower 911. Data reviews were also conducted for survey areas D and E prior to performing verification surveys.

RADIOLOGICAL SURVEY PROCEDURES

Site verification activities were performed during the period March 21 to March 24, and April 25 to April 26, 2005 in each of five survey areas. ESSAP performed surface scans and gamma surface measurements in basement Survey Areas C and D and in the sub-basement Survey Areas E, F, and G (Figures 3 to 7). Scans and direct gamma measurements were performed using low-energy photon scintillation detectors. Survey activities were conducted in accordance with a project-specific plan (ORISE 2004b) submitted to and approved by DOE and supplemented by the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 2004c and 2005a).

REFERENCE GRID

ESSAP utilized the reference system established by K-H and any prominent building features to identify measurement and sampling locations. Measurement and sampling locations were documented on detailed survey maps.

GAMMA SURFACE SCANS

Gamma scans were performed over 90 percent of accessible floor areas of the basement and sub-basement Survey Areas C, D, E, F, and G. The Survey Areas represented the portions of the concrete slab that existed greater than six feet below final grade, which will remain in place following building demolition. Gamma scans were performed using low-energy photon FIDLER detectors coupled to ratemeters with audible indicators. Any area of elevated activity identified during the scan that exceeded the field action level was flagged for further investigation.

GAMMA SURFACE MEASUREMENTS

Gamma surface activity measurements were performed at a minimum of 30 random/systematic locations per survey area. The number of systematic measurement locations was increased for survey areas with a higher potential for contamination. Direct gamma measurements were also performed at locations based upon: (1) areas that were identified by surface scans as having radiation levels greater than the field action level, (2) randomly generated measurement locations, and (3) at locations flagged as suspect. Measurements were performed when necessary to determine the average residual gamma surface activity in the contiguous square meter area. Direct gamma measurements were performed at 229 randomly selected locations and 12 judgmental locations (Figures 3-7). Judgmental locations are identified as B1, B2, etc. Additional measurements were performed to determine the square-meter average activity at five locations.

SAMPLE ANALYSIS AND DATA INTERPRETATION

The radionuclide of concern for Building 371 is 35 year old weapons grade plutonium (WGP) (Pu-239/240). Gamma surface activity measurements were converted to units of nCi/g for WGP based on the calculation method described in Rocky Flats technical basis document

05-RS-0002. The calculated concentration of isotopic plutonium was based on the Am-241 to Pu-239 ratio of 1:8. The results were compared to the 100 nCi/g concentration-based limit as averaged (defined as 0 to 1 cm concrete depth) over 1 m^2 (K-H 2004), as specified in the DOP.

Additional information concerning major instrumentation, sampling equipment, calculation variables, and analytical procedures is provided in Appendices A and B.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP reviewed various documents pertaining to the closure of Building 371 Closure Project such as the characterization plan, DOP, and the Phase II and Phase III PDSRs (K-H 2003, 2004, 2005b and c). ESSAP reviews of the PDSRs generated comments related to the classification of survey units. It was ESSAP's position that survey units (SU) 371066 and 371074 were initially misclassified based on information pertaining to historical use and proximity of the SU to Class 1 units. However, the review did not identify data in excess of the guideline criteria which would require reclassification. A review of the K-H PDSR overall results indicated that K-H performed adequate surveys and that any contamination identified was removed to levels meeting the guideline criteria (ORISE 2005b and c). Prior to initiating the verification surveys, ESSAP reviewed two data sets from Survey Areas D and E to prepare the survey strategy. The data did not identify any issues of concern or particular areas for expanded investigation (K-H 2005a).

GAMMA SURFACE SCANS

BASEMENT

Gamma surface scan results in Survey Area C ranged from 1,000 to 22,000 cpm. The highest activity was identified in the central area of Room 2310 which originally housed a large filter plenum. Scans were not performed in Survey Area D, except in the contiguous square meter area of direct measurement location 20 (B12).

SUB-BASEMENT

Gamma surface scans were performed on 80 to 100 percent of the accessible floor surfaces in Survey Area G of the sub-basement. A portion of Survey Area G was not accessible during the scanning period because of overhead work to remove Building 374. Also, surface scans were not performed in Survey Areas E and F except for in the immediate vicinity of a direct gamma measurement. Scan activity results ranged from 2500 cpm to 930,000 cpm. The highest levels were observed in the north central sub-basement in Rooms 1105, 1111, 1113, 1115, and 1119.

GAMMA SURFACE MEASUREMENTS

Locations that were at or exceeded the predetermined 250,000 cpm field action level were marked for additional investigation. Surface activity measurements were converted from cpm to nCi/g for comparison of surface activity to the concentration-based guideline criteria. FIDLER detectors coupled to ratemeter-scalers with audible output were used to perform gamma surface measurements.

BASEMENT

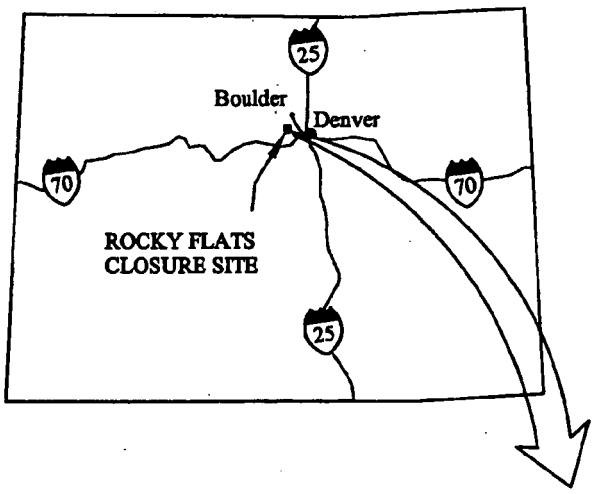
Gamma surface activity measurement results for basement Survey Areas C and D are provided in Tables 1 and 2, respectively. Surface activity measurements ranged from 610 to 1,600 cpm or 0.14 to 0.36 nCi/g for Survey Area C. In Survey Area D, the gamma surface measurements ranged from 960 cpm to 440,000 cpm. Final analytical data quantified this activity as 0.21 nCi/g and 99 nCi/g, respectively. The highest individual reading at location 20 (B12) was the only measurement that exceeded the 250,000 cpm action level. A five point measurement was performed in the contiguous 1 m^2 area that translated into a final concentration of 20 nCi/g.

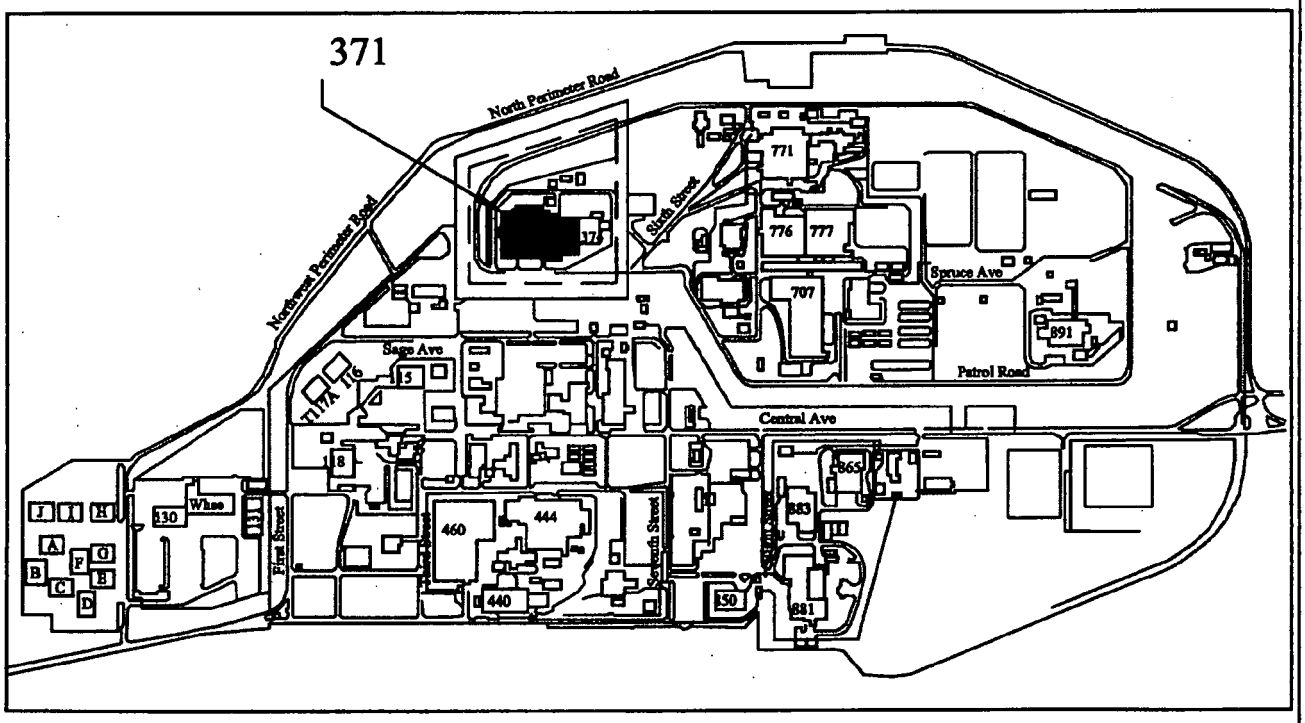
SUB-BASEMENT

Gamma surface activity measurement results for sub-basement Survey Areas E, F, and G are provided in Tables 3 through 5. Surface activity measurements in Survey Area E ranged from 3,000 to 14,000 cpm (0.67 to 3.0 nCi/g). The surface activity measurements in Survey Area F, ranged from 4,200 to 75,000 cpm (0.92 to 17 nCi/g).

Based upon the results of the ESSAP verification effort, all sub-grade slab surfaces greater than six feet below the final grade were below the 100 nCi/g concentration-based guideline. Therefore, it is ESSAP's position that the Building 371 Closure Project meets the DOE allowable contamination guidelines.

FIGURES





N

NOT TO SCALE

FIGURE 1: Location of the Rocky Flats Closure Site

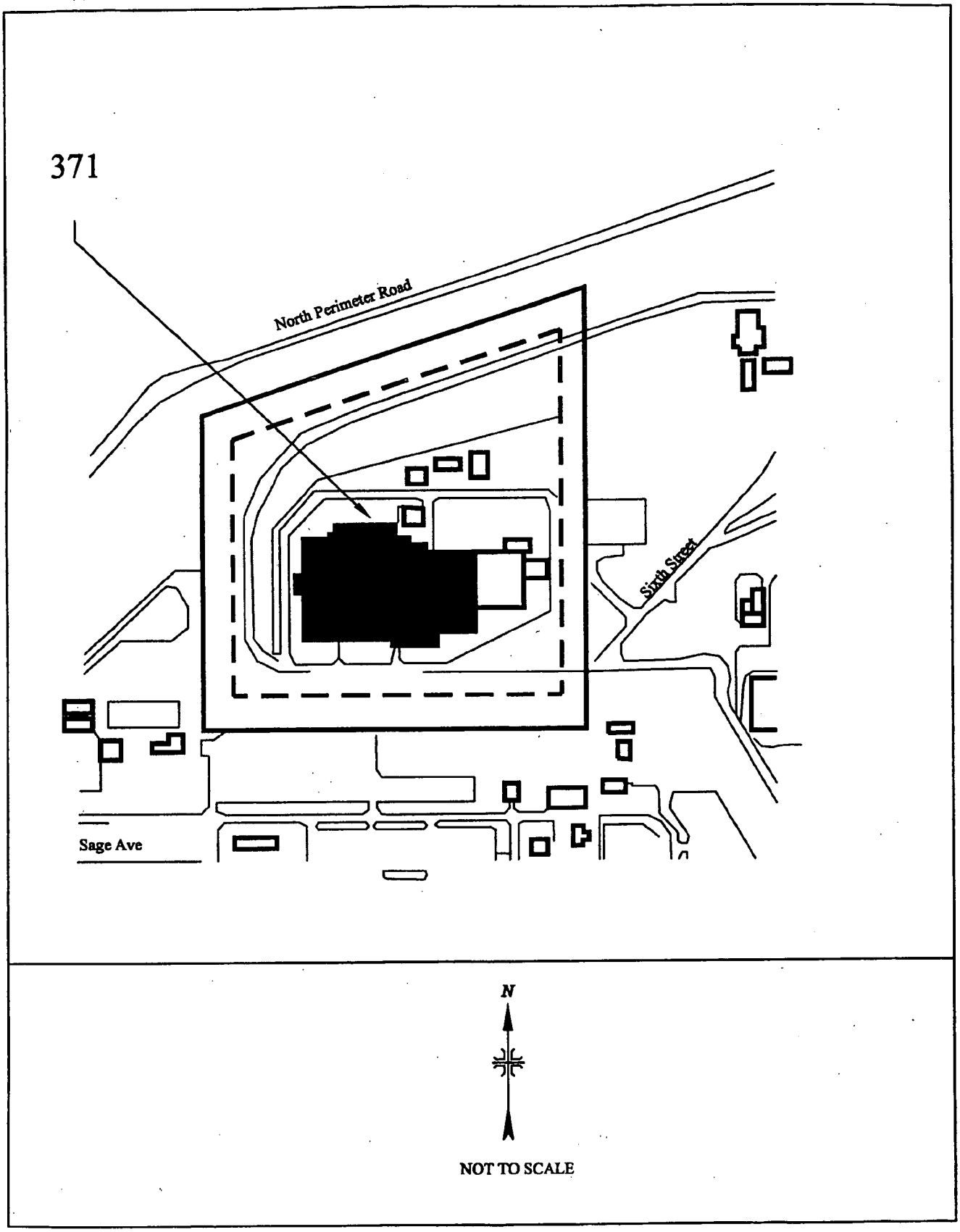
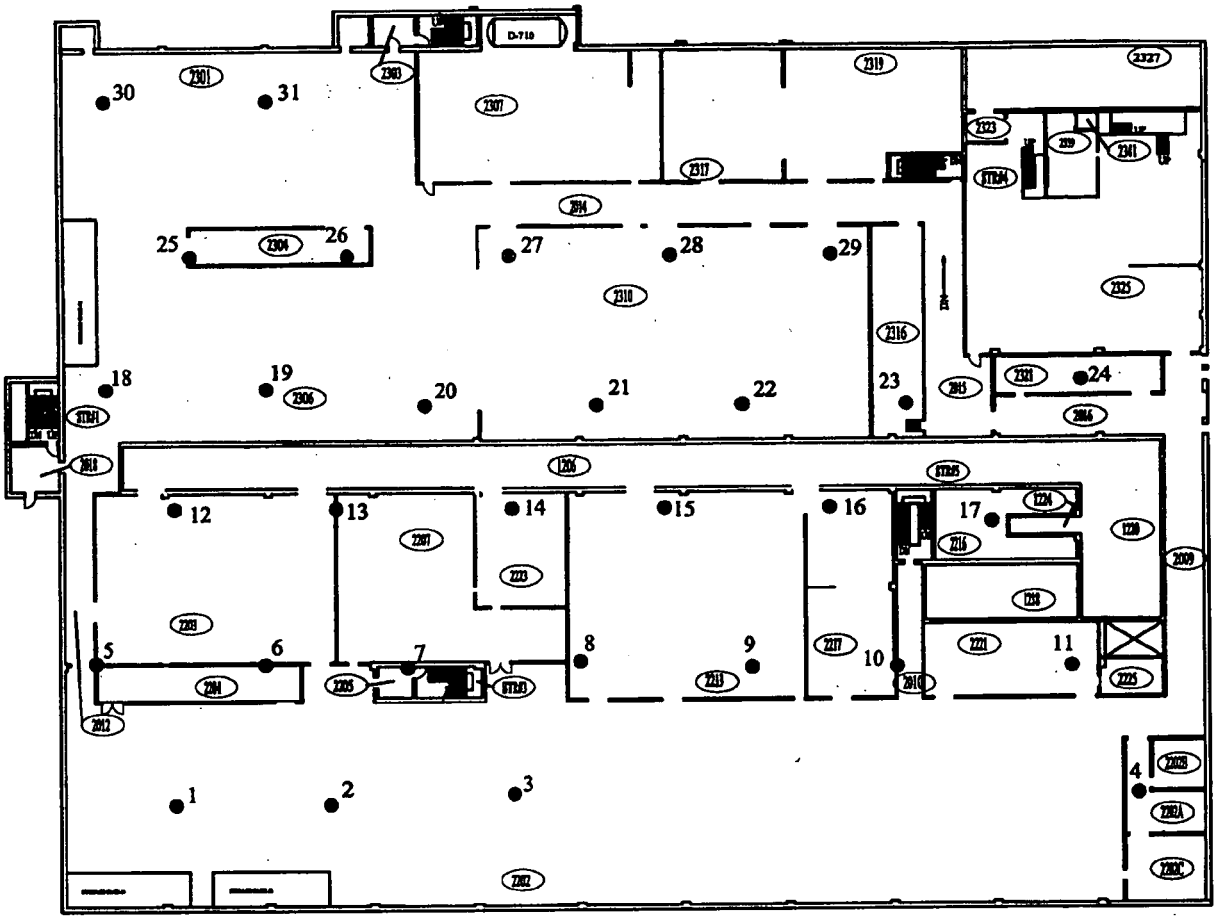


FIGURE 2: Location of the 371 Building



MEASUREMENT LOCATIONS

● # SINGLE-POINT FLOORS

N

FEET 0 30

METERS 0 10

FIGURE 3: Building 371, Survey Area C - Measurement Locations

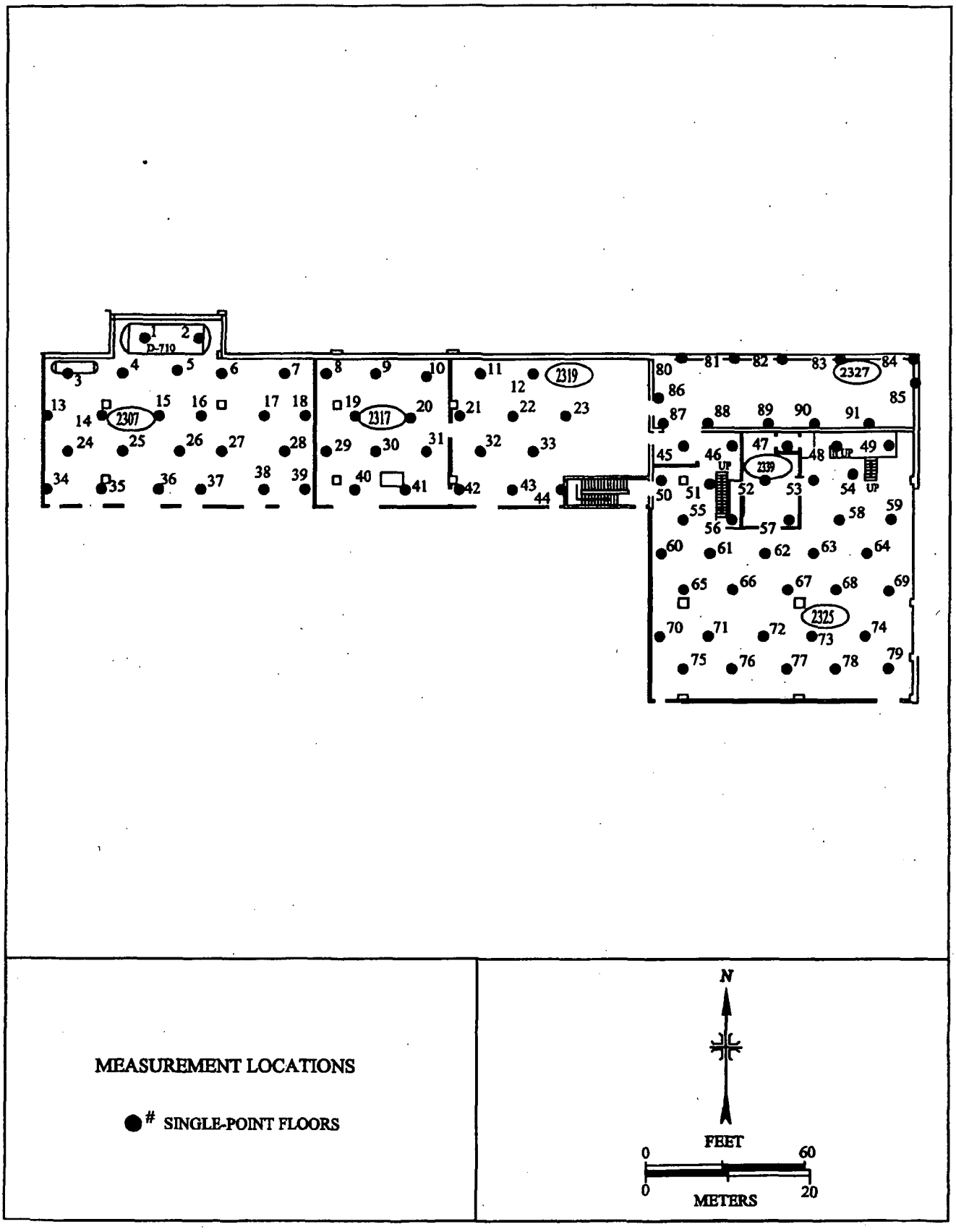


FIGURE 4: Building 371, Survey Area D - Measurement Locations

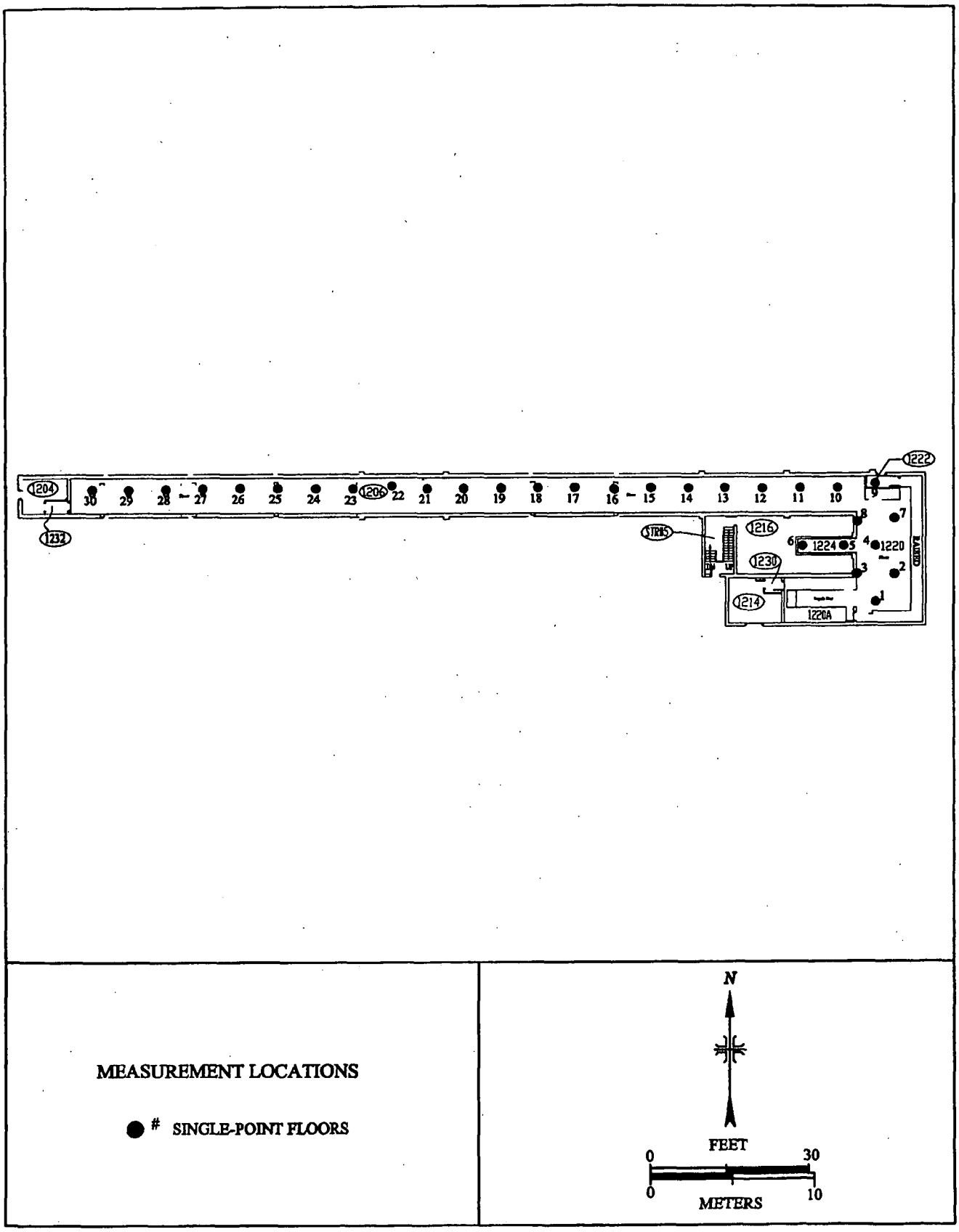


FIGURE 5: Building 371, Survey Area E - Measurement Locations

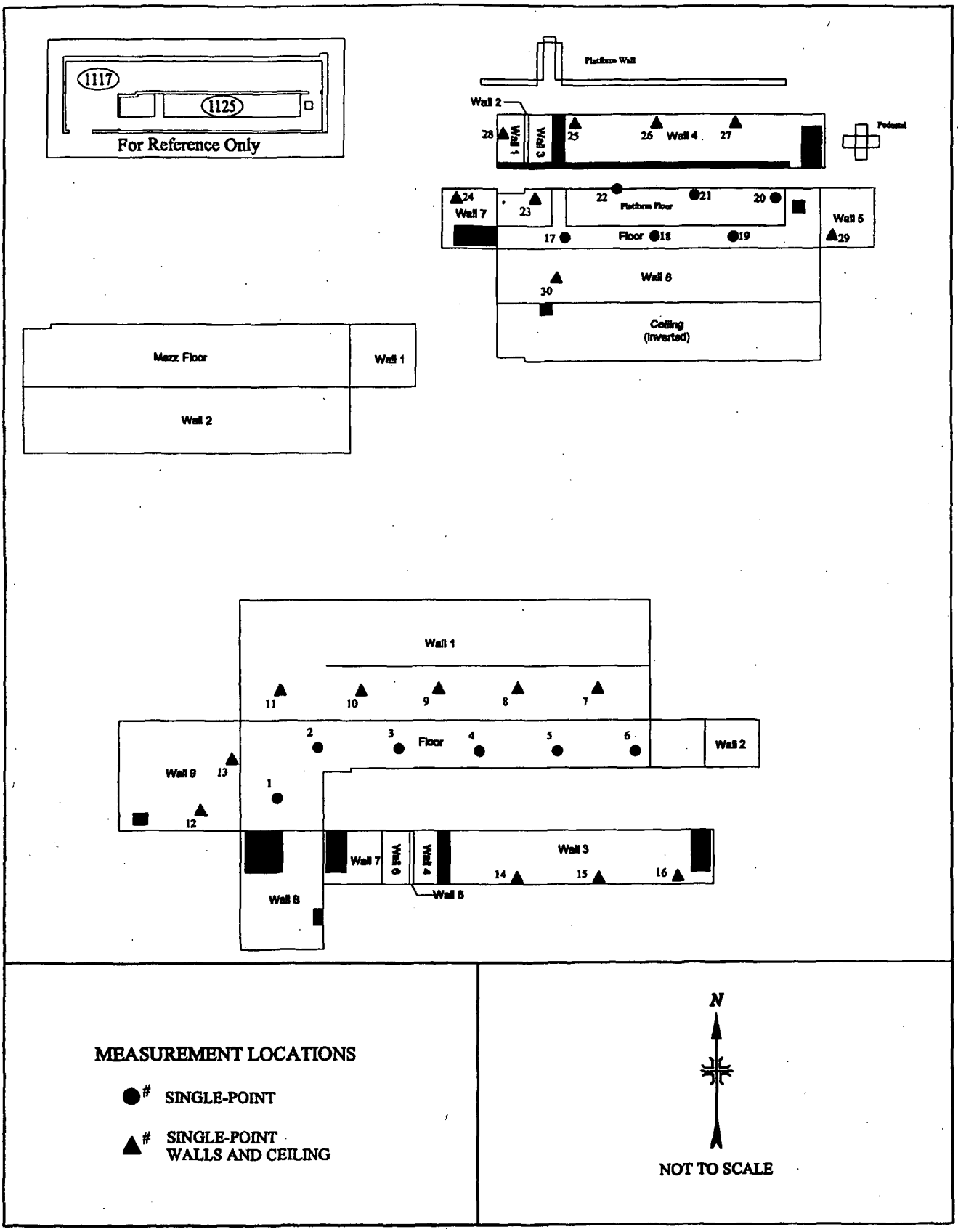


FIGURE 6: Building 371, Survey Area F - Measurement Locations

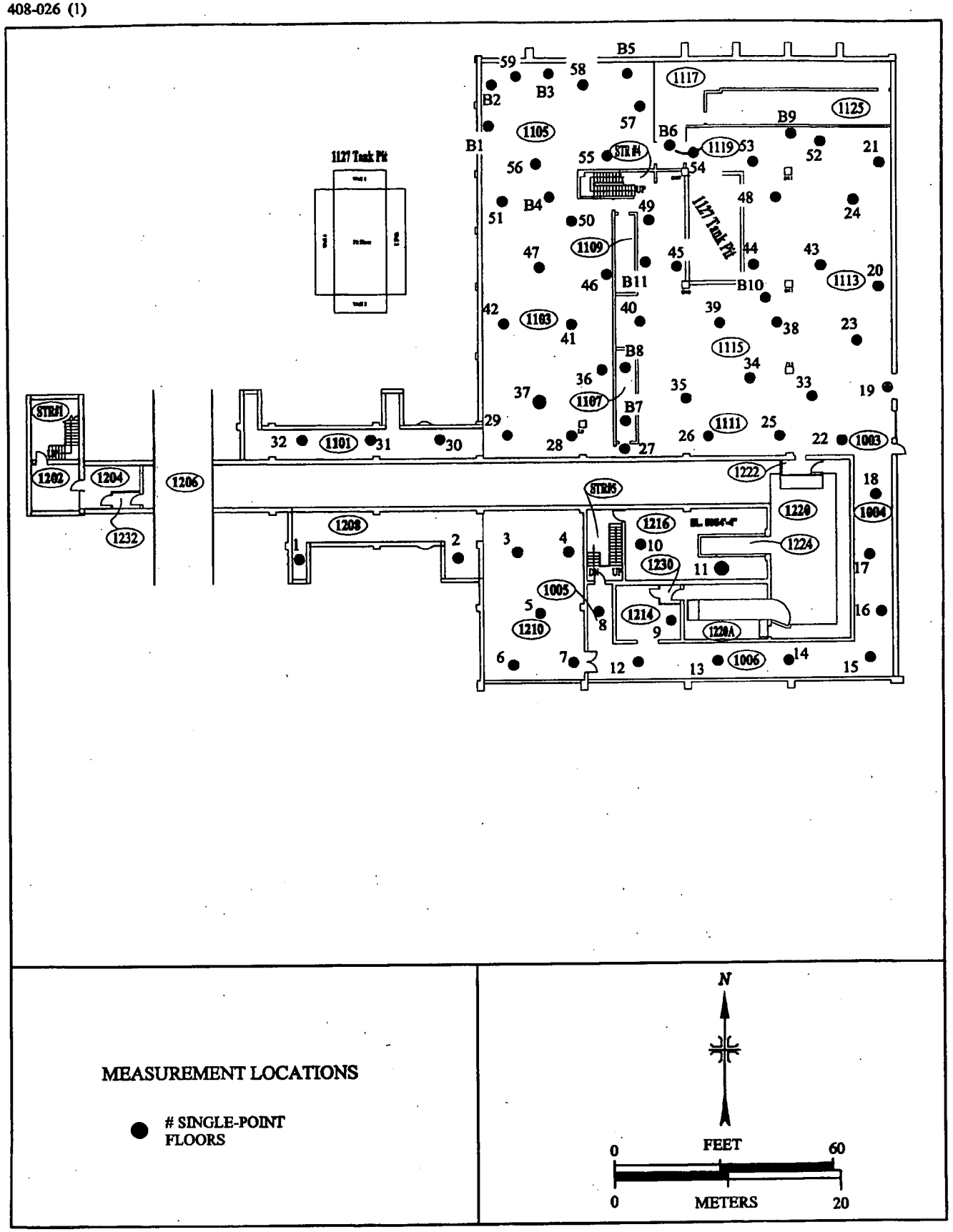


FIGURE 7: Building 371, Survey Area G - Measurement Locations

TABLES

TABLE 1

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA C ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
1	1,100	0.23
2	1,000	0.23
3	1,200	0.26
4	1,400	0.30
5	1,200	0.27
6	1,200	0.26
7	1,400	0.32
8	1,200	0.27
9	1,300	0.28
10	1,200	0.27
11	1,100	0.25
12	1,500	0.33
13	1,200	0.27
14	1,400	0.31
15	1,300	0.29
16	1,400	0.30
17	N/A[c]	N/A
18	1,300	0.28
19	1,000	0.23
20	610	0.14
21	1,300	0.28
22	1,300	0.28
23	1,300	0.29
24	1,200	0.28
25	720	0.16
26	920	0.20
27	1,600	0.36
28	1,200	0.27
29	970	0.21
30	1,300	0.28
31	1,100	0.25
Average Concentration (nCi/g)		0.20

[a]Refer to Figure 3
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.
[c]N/A-Measurement location not accessible.

TABLE 2

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA D ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
1	960	0.21
2	960	0.21
3	1,300	0.28
4	1,100	0.24
5	1,000	0.22
6	1,100	0.25
7	1,300	0.28
8	1,400	0.31
9	1,400	0.31
10	1,300	0.29
11	1,600	0.37
12	1,300	0.30
13	1,200	0.27
14	1,200	0.27
15	1,200	0.26
16	1,100	0.25
17	1,300	0.29
18	1,200	0.26
19	4,400	0.97
20 (B12)[c]	440,000	99
1 m^2 average at loc. 20[d]	90,000	20
21	1,500	0.33
22	1,400	0.30
23	1,700	0.37
24	1,100	0.25
25	1,100	0.25
26	1,100	0.25
27	1,100	0.25
28	1,200	0.27
29	150,000	34
30	1,400	0.32
31	1,300	0.29
32	1,600	0.35
33	1,400	0.32
34	1,100	0.25

TABLE 2 (Continued)

GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY AREA D
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
35	1,000	0.23
36	1,100	0.25
37	1,100	0.25
38	1,100	0.25
39	1,100	0.25
40	1,300	0.28
41	1,300	0.29
42	1,400	0.32
43	1,200	0.28
44	1,500	0.34
45	1,700	0.37
46	1,800	0.39
47	1,600	0.35
48	1,400	0.32
49	1,500	0.34
50	1,800	0.39
51	1,900	0.43
52	1,600	0.35
53	1,500	0.33
54	1,600	0.35
55	2,200	0.49
56	1,800	0.40
57	1,600	0.35
58	1,700	0.37
59	1,600	0.36
60	1,400	0.30
61	1,600	0.36
62	1,600	0.36
63	1,800	0.39
64	1,600	0.36
65	1,800	0.40
66	13,000	2.9
66 (0.3 NE of original)	31,000	6.9
67	1,800	0.39
68	1,400	0.32

TABLE 2 (Continued)

GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY AREA D
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
69	1,400	0.31
70	1,500	0.32
71	2,000	0.44
72	1,400	0.30
73	1,400	0.32
74	1,400	0.31
75	1,300	0.30
76	1,300	0.30
77	2,000	0.44
78	1,400	0.32
79	1,300	0.30
80	6,700	1.5
81	5,300	1.2
82	6,500	1.4
83	3,300	0.73
84	2,300	0.50
85	2,000	0.45
86	2,500	0.55
87	2,500	0.55
88	5,800	1.3
89	4,400	0.97
90	3,000	0.66
91	2,300	0.51
Average Concentration (nCi/g)	[redacted]	2.1

[a]Refer to Figure 4
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.
[c]Location 20 is a direct measurement location that exceeded the 250,000 cpm action level.
[d]Average consists of five measurements collected within the contiguous square meter area.

TABLE 3

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA E ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
1	4,700	1.0
2	4,800	1.1
3	6,300	1.4
4	4,600	1.0
5	3,000	0.67
6	3,300	0.74
7	5,700	1.3
8	14,000	3.0
9	4,100	0.92
10	6,000	1.3
11	5,000	1.1
12	5,200	1.2
13	5,100	1.1
14	5,300	1.2
15	4,700	1.0
16	5,000	1.1
17	5,700	1.3
18	5,100	1.1
19	6,800	1.5
20	6,500	1.5
21	6,100	1.4
22	9,000	2.0
23	6,000	1.3
24	7,100	1.6
25	5,400	1.2
26	4,900	1.1
27	4,600	1.0
28	4,600	1.0
29	4,500	0.99
30	4,600	1.0
Average Concentration (nCi/g)		0.95

[a]Refer to Figure 5
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.

TABLE 4

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA F ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
1	13,000	3.0
2	20,000	4.5
3	10,000	2.3
4	15,000	3.3
5	5,400	1.2
6	9,100	2.0
7	5,400	1.2
8	4,600	1.0
9	46,000	10
10	4,300	0.95
11	27,000	5.9
12	4,900	1.1
13	6,700	1.5
14	34,000	7.6
15	4,500	1.0
16	4,200	0.94
17	6,200	1.4
18	5,000	1.1
19	5,600	1.3
20	9,100	2.0
21	5,000	1.1
22	28,000	6.2
23	75,000	17
24	4,400	0.97
25	4,500	1.0
26	4,800	1.1
27	4,200	0.92
28	4,400	0.98
29	10,000	2.2
30	21,000	4.6
Average Concentration (nCi/g)	[redacted]	2.3

[a]Refer to Figure 6
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.

TABLE 5

GAMMA SURFACE ACTIVITY LEVELS AND VOLUMETRIC CONCENTRATIONS SURVEY AREA G ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
B1	250,000	55
1 m^2 average at loc. B1[c]	53,000	12
B2	54,000	12
B3	40,000	8.9
B4	100,000	23
B5	62,000	14
B6	88,000	19
B7	97,000	22
B8	120,000	28
B9	260,000	57
1 m^2 average at loc. B9[c]	56,000	12
B10	640,000	140
1 m^2 average at loc. B10[c]	140,000	31
B11	900,000	200
1 m^2 average at loc. B11[c]	180,000	41
1	4,200	0.94
2	4,300	0.96
3	4,000	0.89
4	3,600	0.81
5	4,200	0.92
6	4,400	0.99
7	3,900	0.88
8	4,100	0.91
9	3,300	0.74
10	3,900	0.87
11	3,800	0.84
12	5,200	1.2
13	4,200	0.93
14	3,900	0.86
15	4,000	0.89
16	4,100	0.92
17	3,800	0.84
18	4,100	0.90
19	3,100	0.69
20	3,900	0.88

TABLE 5 (Continued)

GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY AREA G
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
21	4,900	1.1
22	4,100	0.92
23	3,300	0.72
24	5,000	1.1
25	4,300	0.95
26	4,500	1.0
27	3,700	0.81
28	4,400	0.98
29	4,400	0.97
30	4,200	0.92
31	4,200	0.93
32	4,100	0.91
33	4,700	1.1
34	4,300	0.95
35	4,600	1.0
36	4,200	0.93
37	4,400	0.97
38	5,000	1.1
39	4,800	1.1
40	5,300	1.2
41	4,200	0.93
42	4,200	0.94
43	4,400	0.98
44	3,900	0.86
45	4,200	0.93
46	4,300	0.96
47	4,300	0.96
48	4,100	0.90
49	3,800	0.84
50	4,100	0.92
51	4,300	0.95
52	7,200	1.6
53	4,200	0.93
54	20,000	4.4

TABLE 5 (Continued)

**GAMMA SURFACE ACTIVITY LEVELS
AND VOLUMETRIC CONCENTRATIONS
SURVEY AREA G
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE
GOLDEN, COLORADO**

Location[a]	FIDLER Result (cpm)	ESSAP Calculated Concentration (nCi/g)[b]
55	3,800	0.85
56	4,000	0.90
57	3,500	0.78
58	4,100	0.91
59	3,100	0.70
Average Concentration (nCi/g)		8.5

[a]Refer to Figure 7
[b]Calculated concentration based on assumptions in Rocky Flats Calculation Number 05-RS-0002.
[c]Average consists of five measurements collected within contiguous square meter.

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APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or employer.

SCANNING INSTRUMENT/DETECTOR COMBINATIONS

Gamma

Ludlum Ratemeter-Scaler Model 2221
(Ludlum Measurements, Inc., Sweetwater, TX)
coupled to
BICRON NaI Scintillation Detector
Model G5 FIDLER
(Bicron Corporation, Newburg, OH)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

PROJECT HEALTH AND SAFETY

A walkdown of the project area was performed to evaluate the survey areas for potential health and safety issues that may not have been identified by the site. Additionally, the proposed survey and sampling procedures were evaluated to ensure that any hazards inherent to the procedures themselves were addressed in applicable job hazard analyses (JHAs). The procedures entailed minimal potential hazards that were currently addressed in ESSAP JHAs.

Personnel adhered to the site health and safety requirements. Project training requirements were met prior to entry into the survey areas. General employee radiological training for site access was completed and the IVT completed beryllium worker qualification, including on-site physical, chest x-ray, and classroom lecture. In addition, the IVT received building specific entry and safety requirements. Confirmatory survey activities were conducted in areas that were not downposted for radiation or beryllium contamination and site dosimetric considerations were applicable.

QUALITY ASSURANCE

Calibration

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the ESSAP:

- Survey Procedures Manual (September 2004)
- Laboratory Procedures Manual (June 2005)
- Quality Assurance Manual (July 2005)

The procedures contained in these manuals were developed to meet the requirements of Department of Energy (DOE) Order 414.1C and the U.S. Nuclear Regulatory Commission

Quality Assurance Manual for the Office of Nuclear Material Safety and Safeguards and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in MAPEP, NRIP, and ITP Laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Instrumentation had to be re-calibrated at the site because of the effect of altitude on detection capability.

The gamma calibration efficiency for the FIDLER detector was determined to ISO-7503 recommendations. A NIST traceable Am-241 calibration source (maximum gamma energy of 59.5 KeV) was used to develop the optimal instrument efficiency using a 4 π source activity. The calculated ε_{total} ranged between 0.08 to 0.11 depending on the detector. The calibration source emission rates were corrected for geometry when a source larger than the detector was used.

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detector slowly over the surface. The distance between the detectors and surface was maintained at a minimum, nominally about 1 cm. Surfaces were scanned using a low-energy photon FIDLER detector with a detector area 127 cm^2. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument.

Specific scan MDCs for the NaI scintillation detector for the radionuclide mixture in concrete were not determined as the instrument was used solely as a qualitative means to identify elevated gamma activity however, MDCs for radionuclides in the concrete would approximate those contained in NUREG-1507.

Surface Activity Measurements

Measurements for surface activity levels were primarily performed using gas proportional detectors with portable ratemeter-scalers. Surface activity measurements were performed on upper room surfaces, some equipment, and at locations of elevated direct radiation. Gamma surface activity measurements were performed using the FIDLER detector. A Microshield ™ program calculation was performed based upon calibration variables and detector attributes to determine a field action level. The result calculated a field action level of 250,000 cpm that was used to conduct additional investigation.

Gamma count rates were integrated over one minute using the FIDLER. Count rates (cpm) were converted to nanocuries per gram (nCi/g) using the following equation:

$$\left(\frac{cpm}{\varepsilon_T * \varepsilon_p * 127cm^2}\right) * \left(\frac{127\ m^2}{W}\right) * \left(\frac{nCi}{2220dpm}\right) * 8\frac{Pu}{Am}$$

where:

ε_T = Total Efficiency = 0.08
ε_p = Attenuation Correction Factor for Painted Surfaces = 0.679

W = Volume * Density of Concrete = $127cm^2$ * 1 cm * 2.35 g/cm^3 = 298.45 g

Note: Volume is calculated as physical detector area x DCGL depth

8 = ratio of Pu-239 to Am-241 for 35-year old WGP

The area with the highest activity identified was in Survey Area G. Surface activity measurements ranged from 3,100 to 900,000 cpm (0.69 to 200 nCi/g). Eleven of the 70 measurements in this area were biased samples. Of the 11, four locations exceeded the action level (250,000 to 900,000 cpm); thereby, requiring additional investigation. A five point measurement was performed at each location to determine whether or not the average activity over 1 m^2 would satisfy the guideline criteria. After averaging, the highest remaining activity was 180,000 cpm or 41 nCi/g at location B11.

COMPARISON OF RESULTS WITH GUIDELINES

Final results were compared to the 100 nCi/g concentration-based limit as averaged over 1 m^2 of the first centimeter (cm) of concrete depth (K-H 2004). The calculated volumetric concentrations for individual gamma surface measurements ranged from 0.14 to 200 nCi/g. Five measurement locations exceeded the 250,000 cpm field action level. At each location, five point measurements were obtained for the purpose of averaging the activity over the contiguous 1 m^2 areas. All final concentrations were subsequently determined to be less than the DOP surface concentration limit of 100 nCi/g.

FOLLOW-UP ACTIONS AND CONCLUSIONS

The Type A reviews of the K-H PDSRs indicated that K-H performed adequate surveys and that any contamination identified was removed to meet the guideline criteria (ORISE 2005b and c).

During each ESSAP verification effort, K-H obtained comparison gamma surface measurements at each ESSAP measurement location. Furthermore, all locations were discussed and walked-down by K-H prior to ESSAP demobilizing from the site. Since K-H accompanied ESSAP during the collection of measurements, at the close of each survey effort, the ESSAP data points and K-H results were available during close-out. DOE and K-H management were presented with results and at that time any issues raised by ESSAP were addressed. K-H agreed to remediate the locations in the sub-basement that exceeded the 100 nCi/g prior to averaging.